Mobile use, radio signals and health

NetCom

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MOBILE NORWAY

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Mobile use, radio signals and health

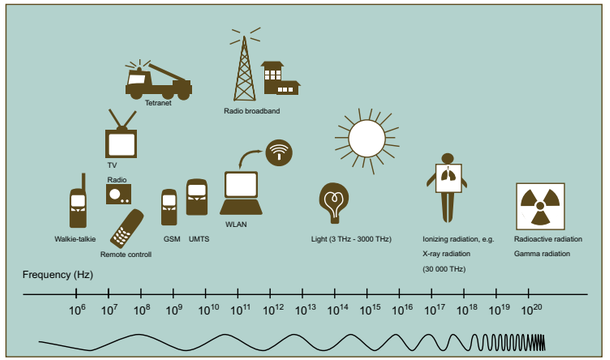
Since the 1970s, the use of various types of radio transmitters has risen dramatically, to the extent that it is now a natural part of everyday life. Walkie-talkies, microwave ovens, wireless baby monitors, radio-controlled toys, cordless phones, remote central locking in cars, and not forgetting the mobile phone, are examples of everyday products that use radio signals to work.

It is quite understandable then that questions are being asked about the possible health risk caused by exposure to the radio waves from these types of transmitters.

In order for us to use mobile phones, the operators have to build networks. The most recent expansion phases were intended to increase capacity and provide users with a faster connection and larger coverage areas.

This pamphlet gives you information on safety related to mobile use and details of the mobile networks we are dependent on.

How does the mobile network work?



Electromagnetic fields

10^3 Hz = 1 Kilohertz = 1 000 Hertz
10^6 Hz = 1 Megahertz = 1 000 000 Hertz
10^9 Hz = 1 Gigahertz = 1 000 000 000 Hertz
10^{12} Hz = 1 Terahertz = 1 000 000 000 000 Hertz

Electromagnetic waves of many different frequencies have surrounded humans from the beginning of time. Sunlight is part of these natural electromagnetic waves.

More than 100 years ago, the first man-made electromagnetic waves were used for radio transmissions and 40 years ago it was the turn of the mobile phone to take up a small section of the "electromagnetic bandwidth".

The mobile phone networks transmit in the range 450 MHz to 2600 MHz. As a comparison, FM broadcasts transmit at a frequency of around 100 MHz. The frequency of visible light is approximately half a million times higher than frequencies used in the mobile networks.

What is a base station?

A base station is an installation consisting of one or more antennas as well as the associated transmitter and receiver equipment. The transmitter and receiver equipment are normally located in a separate room. Their cabinets and cables are so well-shielded that the radio wave leakage out to the surroundings is completely negligible. This is why only the signals transmitted from the antennas are of interest. The base station is the unit which communicates with ("talks to") the mobile phone. Base stations are connected to the rest of the telephone network and are thus absolutely essential for the mobile networks to be able to work.

There are base stations for different types of mobile network. In the early 1990s, the operators started building a GSM network. This is a digital mobile phone system in the 900 and 1800 MHz bands. GSM is classified as a second generation mobile network (2G). In the early 2000s, operators started building the UMTS network. In

a UMTS network, data can be transferred much faster than in the GSM network. UMTS is classified as a third generation mobile network (3G). At the end of 2009, work began on establishing yet another mobile network in Norway, namely LTE or fourth generation mobile network (4G). LTE has even faster data transfer speeds than UMTS.

The antennas for all these mobile networks look quite similar and are mounted in masts, on the fronts of buildings or on the roofs of buildings. The antennas are generally mounted between 10 and 50 metres above the ground. For local areas that are not reached by the larger base stations, smaller base stations or repeaters are also mounted to achieve coverage.

(A repeater is radio equipment that receives a signal from a base station and then forwards it to an area not covered by the base station).

The antennas for these can be positioned at street level in towns or indoors in offices.

How strong is the signal transmitted by a base station?

Base stations for the mobile network transmit at low power, approximately 10-40 watts. As a comparison, large TV stations transmit at 5000 watts and large FM stations at up to 10000 watts. When there is not much traffic at the base station (for example at night), the output is normally even lower than 10-40 watts. Every antenna transmits radio signals virtually horizontally and in a specific direction. The sector in which the radio signals are directed can be compared to the way in which a flashlight sends out a cone of light.

The output of the base stations

The strength of the radio signals subsides rapidly the further they are away from the antenna. The strength of the field can be greater than the international exposure limits inside the main beam direction of the antenna (that is directly in front of the antenna) and within a distance of up to three metres. Normally, however, the antennas are located high above the ground, something which means it is seldom possible to be right in front of them. Should the latter be the case, the mobile operator will have set up barriers or warning signs to prevent people from entering the zone closest to the front of an antenna.

The strength of the radio signals in every other direction than ahead of the main direction of the radio waves is very weak.

The output behind the antennas is significantly lower than in front of it, up to 1,000 times weaker. This means that the exposure at approximately half a metre behind the most powerful antennas will be lower than the international limits. By positioning the antennas on the roof or front of a block of flats, the radio waves inside the apartments will be weaker than if the antennas were located in a nearby mast.

This is due to the "headlight effect"; you are not blinded by your own headlights.

Are all antennas the same?

Ever since the 1920s, we have had antennas which have transmitted radio and then TV signals. The mobile antennas have the same purpose, namely to create a connection or coverage for mobile phone users. But the two types of antenna are not exactly the same:

- Radio and TV signals are one-way communication
- Mobile telephony is two-way communication

The mobile transmitters have a much lower output than the broadcasting transmitters.

How a mobile telephony antenna works

As the illustration demonstrates, the antennas transmit signals in a specific direction like the light from a flashlight. Directly beneath the antenna mast at ground level you will generally have a lower signal strength than, for example, 50-100 metres away from the mast. Due to the fact that the signal strength subsides by 75% every time the distance is doubled, the signal level at this distance is also negligible (less than 0.1%) in relation to international limits.

The research says: no health risk

WHO, the World Health Organization, continuously monitors all research on any health problems that exposure to radio waves can lead to. In its database WHO has compiled around 1,400 studies on the subject which cover radio waves from 100 kHz to 300 GHz. Today's radio signals for mobile telephony are between 450 and 2600 MHz.

WHO's conclusion is that the radio signals from base station antennas do not have any adverse effects on human health.

The Norwegian Radiation Protection Authority has, in cooperation with the other Nordic radiation authorities, conducted an assessment of current base stations and possible health risk. The way antennas for mobile communication normally is placed, radio wave exposure will be very low in areas where people may appear.

The conclusion of the Nordic assessment is that at the present time there is no scientific basis for exposure from base stations with damage to health, as long as the recommended guidelines from ICNIRP* are not exceeded.

The effect or exposure from radio waves in mobile communication is far below international and Norwegian limits. Measurements show that the values in people's surroundings in practice are between 1/1 000 to 1/10 000 of the international and Norwegian limits.

** ICNIRP (International Commission on Non-Ionizing Radiation Protection)*

Common questions about radio waves from mobile antennas:

There is a mobile antenna mast close to our school/nursery. Is that safe?

The signals from mobile antennas mounted in masts or on house roofs/ fronts are so weak that the signal strength indoors would be less than 1% of WHO's recommended limit. This also applies if the antennas are placed on a school roof or a nearby building. Measurements taken over many years confirm that the margins are on the safe side of the limits determined by WHO. In order to exceed 1% of WHO's recommended limit, you would actually have to stand less than 30 metres away from the front of a mast-mounted GSM antenna (that is at the same height and directly in front of the direction the antenna is facing and without obstacles such as windows and buildings, trees, and so on). To exceed WHO's recommended limit, you would have to stand closer than three metres directly in front of the antenna.

The radio signals from base stations are transmitted in a specific direction like the light from a flashlight. Signal strengths greater than 1% of WHO's recommended limit are not experienced underneath the antenna mast or at ground level in front of a building with antennas on the roof or front.

One consequence of having mobile antennas close by is actually that the mobile phones in the area will have a considerably weaker signal. This is because all mobile phones have a mechanism that regulates the output depending on the signal strength from the base station.

Based on the results of research, WHO has issued a recommended limit for people staying in areas with radio signals. The limit depends on the frequency, which is 4.7 watts per square metre for GSM signals (900 MHz) and 10 watts per square metre for 3G and 4G signals (2000 MHz). The difference in limits is due to the different frequencies of the systems.

There are mobile antennas on the roof of the block of flats we live in. Is that safe?

Often the signal strength inside a building will be lower if the mobile antenna is placed on the roof or the front of the building than if it is on a neighbouring building. This is because the radio signal from mobile antennas is transmitted in a specific direction like the light from a flashlight. Normally the signals are transmitted in a beam at an angle Approximately 5-10 degrees downwards from the antenna. The signal spreads horizontally to Approximately 35 degrees on each side of the facing direction. Behind, above, underneath and to the side of the antenna, the signal is only 1-10% of the strength it has in the direction the antenna is facing. This is why only a weak single is transmitted down from the roof on which the antenna is located, and an even weaker signal from behind the antenna and through the wall on which the antenna is mounted

How much power does a mobile antenna in a mast or on a building transmit?

The transmitted output from an outdoor mobile system antenna is usually 10-40 watts, sometimes considerably lower. You would have to be closer than Approximately 3 metres (directly in front of the antenna and at the same height) to achieve signal strengths on par with the international limit recommended by WHO and the Norwegian Radiation Protection Authority.

The operators may use a low output transmitter or an amplifier to provide small areas with mobile coverage. Something that these types have in common is that the maximum transmitted output will only be Approximately 1 watt, that is similar to a GSM phone. This means that the antennas can be put in areas where the distance to private houses and other installations is shorter without these areas receiving stronger radio signals than other areas.

How much radiation do indoor mobile antennas emit?

Unlike outdoor mobile antennas which have to cover areas of up to a hundred square kilometres, indoor mobile antennas only need to cover a few floors of a building within Approximately 100 metres. For this to work, much lower output power is required than for outdoor antennas. The output power from indoor mobile antennas is between 0.01 and 1 watt, depending on the number of floors and building area they have to cover. Another type of antenna solution is also used where the antennas are much smaller and also spread the signal in practically every direction. In other words, there are no special areas which entail significantly greater exposure than other areas. In practice, the signal strength from an indoor antenna is on par with the strength achieved if an "active" mobile phone were to be placed in the same place that the antenna is mounted.

Why are there often many antennas, sometimes from several operators, all in the same place? Yet another mobile network (4G) is currently being planned and built. What will the total signal output be?

In Norway, Telenor, Netcom and Mobile Norway all have licences for different types of mobile network (GSM, UMTS, LTE). Similar multi-operator situations apply in other countries. This tends to mean a separate antenna for every mobile system. In some cases, the operators want to mount antennas in the same place because this location provides the coverage desired for the area.

The same requirements apply, regardless of whether an installation has one or more antennas: the limits must not be exceeded in areas where people may be present. When measurements are taken at such installations, the total signal is always measured, which in turn is then compared to relevant limits. If several of the antennas face the same direction, the reason for this is that signals are being transmitted from different mobile systems or from several operators in this particular direction. These antennas will relieve each other by each of them taking their share of the mobile calls. The overall intensity of radio waves at a specific point is thus not necessarily noticeably stronger just because several antennas are in use.

Do mobile system antennas transmit 24 hours a day?

Yes. But at times when mobile traffic is low the signals from the antennas will be weaker. The difference is particularly great for UMTS antennas (3G), for which the transmitted output from the antennas during periods of low mobile traffic is reduced to 10% compared to the signal strength in periods of maximum mobile traffic.

Do large antennas transmit stronger signals than small antennas?

No, compared to smaller antennas, larger (taller) antennas will have a reduced signal strength in all directions other than the direction they are facing.

Normally, the immediate surroundings will benefit from the use of large antennas since they effectively prevent the signal from being spread in other directions than straight ahead.

Is it safe for children to play next to mobile antenna masts?

If we consider safety in relation to the risk of exposure to radio waves that are too strong, the fact of the matter is that all mobile antenna masts involve very weak levels of exposure down on the ground beneath and around the mast. This is because the antennas transmit the radio signal in a very narrow beam which only to a small extent points down towards the ground. If someone stands directly underneath the mast, their exposure to radio signals can in principle be compared to the light they would receive if they stood with a flashlight pointed straight ahead instead of the beam from a flashlight pointed directly into their face.

How can I be sure that this information is accurate?

Mobile operators themselves generally do not carry out research on possible health effects caused by exposure to radio waves. However, as previously mentioned, extensive international research in the field is currently taking place, and WHO, the World Health Organization, monitors this research closely.

Internationally

ICNIRP (International Commission on Non-Ionizing Radiation Protection) is an independent, non-commercial organisation for non-ionising radiation (including radio waves, see frequency illustration) which evaluates the results of research from studies carried out to identify any links between health and the influence of radio signals. Based on an in-depth review of the literature and research available at the time, ICNIRP draws up guidelines and limits for human exposure to radio signals. The organisation has been formally recognised by WHO, the World Health Organization, and ICNIRP's limits and guidelines for exposure to radio signals have been recommended by WHO.

These limits are reviewed periodically and updated if necessary. A statement on such a review published in July 2009 upholds WHO's limit recommendations.

The limits depend on the frequency, that is what sort of radio network or transmitters are involved. The radio network which is the most well-known and has the best coverage is the broadcasting network which transmits radio and TV signals.

Norway

In Norway it is the Norwegian Radiation Protection Authority that determines guidelines and the limits that the mobile operators must follow. The Norwegian Radiation Protection Authority also carefully monitors all the research being carried out and it is WHO's recommendations that apply in Norway. The mobile operators in Norway follow these guidelines when installing mobile antennas.

Limits and measurement method

In Norway the mobile operators follow the international limits determined by ICNIRP and recommended by WHO. The limits are based on the only known effect that radio waves have on people, namely the slight temperature increase in human tissue. Research into non-thermal influences has also been reviewed. It is impossible to prove such influences do not exist, but theories about non-thermal influences have received only limited support through research. Regardless of this, current WHO limits contain a significant safety margin.

The starting point for measurements is a 1°C increase in tissue temperature (entailing a safety margin of 3°C since the body will remain undamaged at temperatures up to 41°C). This figure is then divided by 50 to take unknown biological effects into account. This means that the exposure limit corresponds to an increase in temperature of 0.02°C.

An increase in temperature of this size is, however, difficult to measure in the field or on the street. As a consequence, these values have been converted to sizes which can be measured using measuring devices.

The unit measured is called field strength – or power density – and is measured in volts per metre and watts per square metre (W/m²).

An increase in temperature of 0.02°C due to a GSM antenna translates into 4.7 W/m² using a measuring device which displays watts per square metre. This is thus the limit for GSM.

The limits for other mobile systems, for example UMTS/3G, will be somewhat different since they use other frequencies.

Limits and typical values

Recommended limit for long-term human exposure (WHO)	4,7 W/m², GSM900 8,9 W/m², GSM1800 10 W/m², UMTS /3G 10 W/m², LTE /4G
Measured signal 1 metre directly in front of an outdoor base station antenna	2 – 17 W/m²
Measured signal 30 metres directly in front of an outdoor base station antenna	0,08 W/m²
Measured signal 1 metre directly beneath or behind an outdoor base station antenna	Less than 0,02 W/m²
Measured signal in an apartment 4 metres directly beneath base station antennas	Less than 0,0001 W/m²
Measured signal “in the streets” of Oslo	0,0007 – 0,003 W/m²
Measured signal 1 metre from an active GSM phone	0,0007 – 0,02 W/m²
Measured signal in front of a switched on microwave oven	At or around 0,2 W/m²
Measured signal next to a cordless phone, during a call	At or around 0,01 W/m²
Measured signal 0.3 metres from a wireless router (WiFi)	At or around 0,02 W/m²

We hope this pamphlet has provided you with satisfactory answers and information on how radio signals and the mobile network work.

For more information about health and mobile telephony, go to:

WHO: http://www.who.int/peh-emf/about/WhatisEMF/en/index.html

Norwegian Radiation Protection Authority: http://www.nrpa.no

Norwegian Post and Telecommunications Authority: http://www.npt.no

GSM World: http://www.gsmworld.com/our-work/public-policy/health/reports_statements_index.htm
(Overview of 160 publications from independent organisations on radio waves and health)